# 2. Impact of the Water Bank on Farm Input Purchases, Crop Sales, and Farm Income

This section presents our findings on the impact of the 1991 Drought Water Bank on the purchases of farm inputs and on crop sales by farmers participating in the Bank. The section is organized by the economic sector affected by the Bank. We first investigate the impact of the Bank on the businesses and individuals who provide farm inputs by estimating the impact of the Bank on farmer input purchases. We then investigate the impact of the Bank on the processors and handlers of farm outputs by estimating the impact of the Bank on crop sales. To do this, we use data from a survey of farmers participating in the Bank and develop a methodology that isolates the impact of the Bank from confounding factors. To assess possible variation in the Bank's impact by type of contract and type of crop put in the Bank, we separately investigate impacts by contract type and crop. We also investigate how the impacts are distributed across the counties where farmers and water agencies sold water to the Bank and how these impacts compare with overall county agricultural activity.

In the last part of this section, we turn our attention from the third parties affected by the Bank to the farmers, landlords, and water agencies that sold water to the Bank. We combine the changes in operating costs and crop sales with Bank payments to determine the overall profitability of Bank sales to farmers, landlords, and water agencies. The section concludes with a brief summary of the findings. Before presenting our findings, we discuss how we collected the data used in the analysis.

## Data Collection and Characteristics of the Data

We interviewed farmers participating in the Water Bank regarding their farm operation in 1990 and 1991. We collected detailed information on the crops planted and harvested in each year, water use, and yield. We determined how much farmers spent on inputs, such as labor, seed, fertilizer, pesticides, contractors (such as pesticide applicators and crop harvesters), fuel, crop haulers, and rentals in each year, and their income from crop sales. We also asked farmers how much more or less than usual they spent on farm investments. Below, we describe our survey methodology, how we assembled the sample

frame (the list of farmers from which we drew our sample), how we selected the sample, and response rates. We then present some characteristics of the data.

## *Survey Methodology*

We developed a survey questionnaire to collect the desired data and fielded the survey over the phone. To do this, we first called farmers and asked them if they would consider participating in the study. We described the study and pledged to keep any data they provided confidential to the extent legally possible. We told them we would mail information on the study and concluded the initial call by arranging a convenient time to call back.

The information packet included descriptions of RAND, the study, and the type of data we needed. This allowed farmers to gather the requested data prior to the follow-up call. When we called back, we asked the farmer if he or she was willing to participate and, if so, proceeded with the interview. The interviews, on average, took about 45 minutes, but some took as long as two hours.[1]

## *The Sample Frame and Sample Selection*

DWR provided a list of landlords, farmers, and water agencies with whom it had contracts and, for no-irrigation contracts, the acreage and type of crop put in the Bank. The list was fairly complete for no-irrigation contracts. However, in a number of cases where DWR signed a contract with a water agency that acted as a broker for individual farmers, we were not given information on the individual farmers. We spent several months obtaining many of these names, because their release usually required approval of the agency's board of directors. As shown in Table 2.1, DWR signed no-irrigation contracts with more than 303 farmers who sold 420,000 acre-feet to the Bank.[2]

We drew a stratified random sample of the farmers with no-irrigation contracts. To increase the fraction of water sold to the Bank represented in the sample, we included all the farmers who put at least 2,000 acres in the Bank. These 12 farmers accounted for 30 percent of total acreage put in the Bank with no-irrigation contracts. Corn and wheat accounted for approximately 60 percent of the acreage in the Bank so, to increase the likelihood that other crops were well represented in the sample, we stratified the farmers according to the primary

[1]The survey instrument and protocol were tested on eight farmers before the survey was fielded.

[2]In a few cases, we were unsuccessful in obtaining the names of farmer participants.

**Table 2.1**

**Number of Farmers and Water Sales Participating in Entire Bank and Survey by Contract Type**

| | Entire Bank | | Survey | |
|---|---|---|---|---|
| Type of Contract | Acre-feet (000s) | Farmers | Acre-feet (000s) | Farmers |
| No-irrigation | 420 | 303+ | 149 | 78 |
| Groundwater-exchange and multiple-response | 240 | 186+ | 24 | 21 |

crop in the Bank and undersampled those whose primary crop was wheat or corn. One water agency that had a fallowing contract was so late in responding to our request for crop, farmer, and acreage information that we had to randomly draw a sample from this group.[3] Overall, we sampled 141 of the 303 farmers with no-irrigation contracts.

DWR signed groundwater-exchange contracts with 10 water agencies and two individual farmers and multiple-response contracts with two water agencies.[4] For 11 of the 12 agencies, DWR had no records of the individual farmers affected by the agency sale. We attempted to obtain the names and phone numbers of the farmers affected by these "black-box" contracts. Including the farmers that were named by the twelfth agency, we were able to identify 184 such farmers, but a few agencies were unwilling to provide this information either because of the time required or concerns about confidentiality. Thus, we do not know how many farmers overall were affected by groundwater-exchange and multiple-response contracts. We suspect, however, that, counting the two farmers with direct contracts with DWR, these 186 farmers likely constitute the majority of affected farmers. Since we did not have data on acre-feet sold to the Bank by individual farmers, we drew a random sample from farmers with groundwater exchange and multiple-response contracts. Overall, we selected 70 of the 186 farmers we could identify.

## *Response Rate*

The survey was fielded in two waves. The first wave ran from February through April 1992. As spring approached, farmers became increasingly busy, and few

[3]The proportion of farmers sampled in this group was the same as the proportion for the remaining farmers.

[4]The water agencies with multiple-response contracts were the Joint Water District Board and the Western Canal Water District, which are primarily in Butte county.

surveys were completed toward the end of the period.[5] Preliminary analysis of the data indicated that we needed to increase the number of responses, so we fielded a second wave of the survey from September through November 1992 when the farmers were less busy.

We were unable to contact 46 of the 211 farmers in the survey sample because we could not find phone numbers or because no one ever answered the phone or returned our call. Of the remaining 165, 99 (60 percent) completed the telephone interview. The most common reason farmers declined to participate was lack of time. Some farmers also cited concerns about confidentiality or ongoing or potential litigation about the Bank as reasons for declining to participate.[6] We dropped four observations from the analysis in this section. Two observations were dropped because a few critical pieces of information were unavailable. Two other observations were dropped because these farmers had both no-irrigation and groundwater-exchange contracts, and we investigate each separately. We thus base on findings on 95 farmer interviews.

## *Characteristics of the Data*

The farms average 1,314 acres in size for the 76 farmers in our sample with no-irrigation contracts (see Table 2.2). On average, these farmers put 57 percent of their operation in the Bank and sold an average of 1.45 acre-feet of water per acre in their entire farm operation. Farm size was somewhat smaller on average for the 19 farmers affected by groundwater-exchange and multiple-response contracts, and they sold 1.02 acre-feet per acre to the Bank on average.

**Table 2.2**

**Size of Operation and Amount of Water Sold to Bank by Type of Contract**

| | No-Irrigation Contracts | Groundwater-Exchange and Multiple-Response Contracts |
|---|---|---|
| Observations | 76 | 19 |
| Average size of 1991 operation (acres) | 1,314 | 1,075 |
| Average percent of operation in Bank | 57 | NA |
| Average water sold (AF/acre) | 1.45 | 1.02 |

[5]Often, interviews were repeatedly rescheduled—in some cases, up to ten times.

[6]In some cases, landlords held the contract with DWR but refused to refer us to their tenants or cooperate with the survey.

Across the Bank participants, there is wide variation in the amount of water sold to the Bank per acre. Figure 2.1 illustrates that the amount of water sold to the Bank varies from less than 0.5 acre-feet per acre in the farmer's operation to 3.5 acre-feet per acre. In the case of no-irrigation contracts, some farmers put their entire operation in the Bank. Since DWR bought, at most, 3.5 acre-feet per acre under no-irrigation contracts, these farmers are represented by the rightmost bar in Figure 2.1. We will use this variation in the amount of water sold to the Bank per acre to isolate the impact of the Bank from other factors.

The amount of water bought by DWR varied by the type of crop. Table 2.3 reports the average water purchased per acre by crop for the farmers in our survey with no-irrigation contracts.

## Impact of the Water Bank on Purchases of Farm Inputs

We now turn to the impact of the Bank on the businesses and individuals that supply farm inputs. We first use the survey data to investigate how the Bank affected farm operating costs and then examine whether farmers used Bank income to make extra investments in their farms. The impact of the Bank on farm operating costs and investment sum to the impact on expenditures for farm inputs.

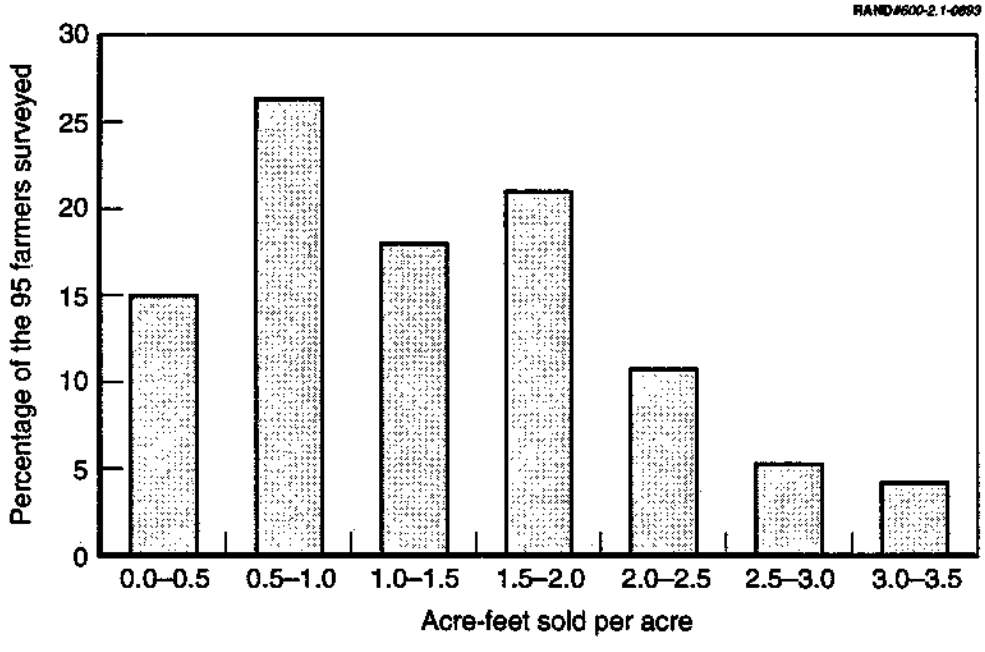


**Figure 2.1—Distribution of Acre-Feet Sold per Acre in Farm Operation**

**Table 2.3**

**Average Water Purchased by Crop for No-Irrigation Contracts (AF/acre)**

| Crop | Average Bank Purchases |
|---|---|
| Wheat | 1.8 |
| Corn | 2.2 |
| Other[a] | 2.5 |
| Sugar beets | 2.8 |
| Pasture | 3.1 |
| Alfalfa | 3.3 |
| Rice | 3.4 |

[a]Primarily dry beans, safflower, sunflowers, and tomatoes.

We may not have been completely able to separate operating costs from farm investments. In the survey, we asked farmers their overall payments for labor, contractors, seed, fertilizer, and other operating costs and then asked them how much more or less than usual they spent on a list of farm investments. We also asked if these costs had been included in the payments disclosed earlier. We think it likely that farmers did not fully detail their farm investments and that some are included in the operating cost totals. Thus, our measure of operating costs may somewhat overstate true operating costs, and our measure of farm investment may understate the true farm investment. Total input purchases, however, should not be affected.

Eight of the farmers in our sample were in agencies with multiple-response contracts. Six saw their surface-water allocation reduced but had no groundwater pumps to offset the reduction. As mentioned in Section 1, these farmers are similar to those with no-irrigation contracts in that their surface-water supplies were reduced but groundwater could not be substituted. We combine these two types of farmers in the following analysis and refer to them collectively as farmers with no-irrigation-like (NIL) contracts. Since almost all of the farmers without groundwater pumps in agencies with black-box contracts primarily grew rice, we combine the acre-feet purchased with the acre-feet generated by fallowing rice under no-irrigation contracts.[7]

Two of the eight farmers in agencies with multiple-response contracts had groundwater pumps to offset surface water reductions. As also mentioned in

[7]We separately estimated the impacts of water bought from rice under no-irrigation contracts and water bought through multiple-response contracts. The impact on operating costs was smaller for multiple-response contracts, but the difference was not statistically significant.

Section 1, these farmers are similar to farmers with groundwater-exchange contracts in that they could offset surface-water reductions with groundwater pumping. In this case, however, pumping was optional, whereas it was mandatory under groundwater-exchange contracts. In the analysis that follows, we combine the two multiple-response farmers with groundwater pumps with those who had groundwater-exchange contracts and refer to them collectively as farmers with groundwater exchange-like (GWEL) contracts.[8]

## *Changes in Farm Operating Cost*

Table 2.4 reports the average operating cost per acre in 1990 and 1991 for the farmers in our survey. For now, we exclude water costs from operating costs because we are concerned about impacts on third parties, and water costs impact the farmers but not third parties in the local economy. We will add them back in when we analyze net farmer proceeds from the Bank later in this section. Operating costs per acre fell between 1990 and 1991 for the 76 farmers in our survey with NIL contracts. Average operating costs per acre fell $49, from $256 per acre to $207 per acre. This amounts to a 19-percent decline.

Throughout our analysis, we focus on changes in operating cost **per acre** in a farmer's **entire** farm operation between 1990 and 1991. We normalize by acres to control for differences in farm size across the farmers in our survey, as well as for changes in farm size between 1990 and 1991.[9] We consider the entire farm operation, because we want to capture any shift in inputs from land in the Bank

**Table 2.4**

**Change in Operating Costs per Acre in Farm Operation (not necessarily attributable to the bank)**

| | NIL Contracts | GWEL Contracts |
|---|---|---|
| Observations | 82 | 13 |
| Average operating cost | | |
| 1990 ($/acre) | 256 | 299 |
| 1991 ($/acre) | 207 | 309 |
| Change ($/acre) | –49 | 10 |
| Change (percent) | –19 | 3 |
| Average water sold (AF/acre) | 1.38 | 1.25 |

[8]We did not find that the impacts of water sales for the two farmers with multiple-response contracts were statistically different from those with groundwater-exchange contracts.

[9]We assume that changes in farm size between 1990 and 1991 for any particular farmer are independent of his/her decision to sell water to the Bank.

to land not in the Bank.[10] We likewise analyze water sales in terms of acre-feet sold per acre in the farmer's 1991 farm operation.

For farmers with GWEL contracts, we see little change in operating costs per acre, even though they sold almost 1.25 acre-feet per acre to the Bank (see Table 2.4).

## *Isolating Impacts of the Bank from Confounding Factors*

We cannot attribute all of the changes in operating costs reported in Table 2.4 to the Bank. Factors other than the Bank may have caused these changes. Examples of such confounding factors include changes in the price of inputs, drought impacts, and an increase in pest problems that would require an increase in pesticide use.

We use regression analysis to isolate the impact of the Bank from other factors. This methodology takes advantage of the wide variation in water sold to the Bank per acre across the Bank participants (see Figure 2.1). The intuition behind the approach is that it is likely that the Bank had little impact on operating costs per acre for farmers who sold a small amount of water relative to the size of their operation and a larger impact for farmers who sold a great deal. The methodology uses this variation to determine the incremental impact on operating costs of selling an additional acre-foot to the Bank. This impact is attributable to the Bank—other factors that might influence operating costs are held constant. Appendix A details the approach.

This methodology does not rely on assumptions about what the farmer would have grown had there been no Bank. For example, farmers may not have planned to grow crops on land they put in the Bank. This would cause the negative impacts of the Bank to be less than they would have been if the farmer had planned to grow crops on the Bank land. Our methodology captures the combined effect of all such responses to the Bank.

## *Changes in Operating Costs Due to the Water Bank*

We first investigate changes in operating costs for farmers with NIL contracts. As shown in Table 2.5, water sales negatively affect operating costs for farmers with NIL contracts, and the impact varies importantly by crop. Water bought

[10]Anecdotal evidence had suggested that such shifts took place on some farms in the Water Bank.

**Table 2.5**

**Change in Operating Cost per Acre Attributable to Water Bank by Contract Type and Crop**

| Type of Contract and Crop | Change per AF sold ($/AF)[a] | 90-Percent Confidence Interval |
|---|---|---|
| NIL contracts | | |
| High impact | | |
| Rice | –79[b] | [–126, –32] |
| Sugar beets | –52[b] | [–75, –28] |
| Alfalfa | –48[b] | [–67, –30] |
| Medium impact | | |
| Wheat | –35[c] | [–66, –4] |
| Corn | –32[c] | [–61, –4] |
| Other[d] | –30[c] | [–57, –1] |
| Low impact | | |
| Pasture | 0 | [–16, 17] |
| GWEL contracts | | |
| Groundwater available | –3 | [–12, 6] |

[a]The units are ($/acre)/(AF/acre) or $/AF.
[b]Significantly different from zero with 95-percent confidence.
[c]Significantly different from zero with 90-percent confidence.
[d]Primarily dry beans, rice, safflower, sunflowers, and tomatoes.

from rice, sugar beets, and alfalfa has the highest impacts. At $79, $52, and $48 per acre-foot, these impacts are sizable, ranging from 19 to 31 percent of the average 1990 operating cost per acre in our sample. As evidenced by the 90-percent confidence intervals, there is considerable uncertainty in these impacts, although they are statistically different from zero with 95-percent confidence.

Wheat, corn, and the average of all other crops[11] not irrigated have a more moderate impact per acre-foot sold. These impacts vary from $30 to $35 per acre-foot, and the estimates are statistically different from zero with 90-percent confidence. The estimated impact for the "Other" category represents the weighted average of all the crops that fall in this category. It may well be that some crops in this category had high impacts (tomatoes, for example) while others had low impacts. We do not have sufficient data to identify their separate impacts, however.

Water purchased by not irrigating pasture appears to have no systematic impact on operating cost per acre.

[11]The main crops in this category are dry beans, rice, safflower, sunflowers, and tomatoes.

We find that there is little change in operating costs per acre for farmers with GWEL contracts. For each acre-foot sold to the Bank per acre in the farm operation, farmers reduced their input purchases per acre by $3 (see bottom line of Table 2.5). This is small relative to the average input purchases per acre in 1990 ($299) and, as demonstrated from the 90-percent confidence interval reported in Table 2.5, is not statistically different from zero.

It appears that the Bank did not affect the overall operating costs of farmers with GWEL contracts, but, as we will see later in this section, this does not mean that the farm operations of these farmers were unaffected. It may also be that there indeed was some impact on operating costs, but we detected no impact, because these operating cost numbers may include some extra farm investment. A cautionary note is warranted for all the results presented on GWEL contracts in this report. The results are based on a small number of observations (13). A larger sample size would give more confidence in the accuracy of the findings.

### *Factors Behind Variation in Impacts on Operating Costs*

What explains the difference between the impact on operating costs across crops for NIL contracts? We investigated whether these differences are correlated with the level of inputs normally used in growing each crop and the type of no-irrigation contract.

One would expect the impact on operating costs to be greater for water bought from crops that normally require greater inputs per acre to cultivate. We do find that the highest impacts are for crops that have the highest normal cultivation costs. Table 2.6 first reports the impact on operating costs per acre-foot sold by crop for NIL contracts and then the average number of acre-feet purchased by DWR for each acre fallowed. The product of these two numbers gives the impact of putting one acre in the Bank (see column 3), which is then compared with the operating cost reported in UC crop budgets.[12] The high-impact crops have the highest crop budgets; pasture has both the lowest impact and the lowest crop budget; and corn and wheat are in the middle.

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[12]Operating costs for each crop were calculated from 1989 crop budgets for sugar beets, alfalfa, rice, corn in Yolo County, wheat (on mineral soil) in Sacramento County, and irrigated pasture in Stanislaus County (University of California Cooperative Extension, 1989). Excluded from the gross crop budgets are interest costs, investment costs (buildings and tractors), taxes, insurance, land rent, and water costs. For alfalfa, costs of stand establishment are also excluded.

**Table 2.6**

**Comparison of Statistical Estimate of Change in Operating Cost Due to Bank with Crop Budget Data for NIL Contracts**

| | Change per AF sold (1) | AF per Acre in Bank (2) | Impact per Acre in Bank (3)=(1) × (2) | UC Crop Budget (4) |
|---|---|---|---|---|
| High impact | | | | |
| Rice | –79 | 3.4 | –269 | 401 |
| Alfalfa | –52 | 3.3 | –171 | 418 |
| Sugar Beets | –48 | 2.8 | –134 | 594 |
| Medium impact | | | | |
| Other | –30 | 2.5 | –75 | — |
| Corn | –32 | 2.2 | –70 | 355 |
| Wheat | –35 | 1.8 | –63 | 265 |
| Low impact | | | | |
| Pasture | –3 | 3.1 | –9 | 103 |

As discussed in Section 1, there are two types of NIL contracts: contracts where the farmer has already planted a crop and agrees not to continue irrigating it[13] and contracts where the farmer does not plant the crop. We expect the impact of the first type of contract on operating costs to be less (other things equal) than the second type of contract, since the farmer has incurred the costs of planting the crop and may go on to harvest a reduced yield.[14]

Since the same crop is not observed under both types of NIL contracts, we cannot evaluate the impact of contract type holding crop constant. We can say, however, that the type of contract by itself is not a very good predictor of the percentage reduction in operating costs. The last column of Table 2.7 reports the ratio of the impact per acre to the crop budget. Alfalfa, for example, is planted but not irrigated, but its impact relative to its crop budget is higher than for either sugar beets or corn, which are not planted. This high ratio may be because, in normal cultivation, alfalfa is cut many times during the growing season, requiring substantial labor and machinery. When deprived of water, there is less growth and fewer or no cuttings, which may cause a substantial drop in input purchases. This suggests that both the particular characteristics of the crop and the type of contract are important in determining the impact on operating costs.

[13]Some crops may actually have been planted in previous years. Alfalfa, for example, frequently stays in the ground for 7 years.

[14]Heavy rain in March 1991 boosted the yield of crops that were planted but not irrigated.

**Table 2.7**

**Relation of Impact of Bank on Operating Costs to Crop Budget by Type of NIL Contract**

| Type of Fallowing Contract | Impact per Acre Fallowed (1) | Crop Budget (2) | Ratio (1)/(2) |
|---|---|---|---|
| Planted, not irrigated | | | |
| Alfalfa | –171 | 418 | –0.41 |
| Wheat | –63 | 265 | –0.24 |
| Pasture | –9 | 103 | –0.08 |
| Not planted | | | |
| Rice | –269 | 401 | –0.67 |
| Sugar beets | –134 | 594 | –0.23 |
| Corn | –70 | 355 | –0.20 |

Table 2.7 also shows that no-irrigation contracts do not reduce operating costs by the full amount of the crop budgets. This is to be expected, because even when the farmer did not plant crops, he or she likely made some preplanting expenditures. It also suggests that farmers may have shifted some of their inputs to land they did not put in the Bank.

## *Changes in the Components of Operating Costs*

Table 2.8 reports changes in the amount spent on the components of operating costs between 1990 and 1991 for the farmers surveyed. While these changes are not necessarily due to the Bank, they suggest how the decline in operating costs due to the Bank may have been distributed.

All components of farm operating costs dropped between 1990 and 1991 on farms with NIL contracts. The biggest absolute declines in purchases per acre were for labor, chemicals, and contractors. Fuel, seed, haulers, and rentals showed smaller absolute declines, but, with the exception of fuel, their percentage drops were comparable to those for the other inputs. Fuel purchases showed the smallest percentage decline between 1990 and 1991. Since fuel prices did not change much between 1990 and 1991,[15] this suggests the use of farm equipment did not change much after farmers sold water to the Bank. Many of the farmers we surveyed with fallowing contracts mentioned that they continued to use equipment to remove weeds or level their fields.

[15]The fuel price index for farms was 204 in 1990 and 203 in 1991 (*Agricultural Outlook*, 1992).

**Table 2.8**

**Changes in Components of Operating Cost per Acre in Farm Operation by Type of Contract**

| | Number of Observations | Average Operating Costs 1990 ($/acre) | 1991 ($/acre) | Change ($/acre) | Change (percent) |
|---|---|---|---|---|---|
| NIL contracts | | | | | |
| Total | 82 | 256 | 207 | –49 | –19 |
| Labor | 82 | 99 | 83 | –16 | –16 |
| Full-time | 74 | 44 | 38 | –5 | –12 |
| Part-time | 74 | 43 | 32 | –10 | –24 |
| Chemicals | 82 | 56 | 45 | –11 | –19 |
| Contractors | 82 | 40 | 30 | –10 | –26 |
| Fuel | 82 | 22 | 20 | –2 | –8 |
| Seed | 82 | 18 | 14 | –4 | –23 |
| Haulers | 82 | 16 | 11 | –5 | –33 |
| Rentals | 82 | 5 | 4 | –1 | –15 |
| GWEL contracts | | | | | |
| Total | 13 | 299 | 310 | 11 | 4 |
| Labor | 13 | 56 | 56 | 0 | 0 |
| Full-time | 11 | 18 | 19 | 1 | 4 |
| Part-time | 11 | 28 | 29 | 1 | 2 |
| Chemicals | 13 | 97 | 100 | 3 | 4 |
| Contractors | 13 | 23 | 24 | 1 | 4 |
| Fuel | 13 | 20 | 22 | 2 | 9 |
| Seed | 13 | 16 | 16 | 0 | 0 |
| Haulers | 13 | 73 | 76 | 3 | 4 |
| Rentals | 13 | 14 | 15 | 1 | 12 |

Both the absolute and percentage drops in payments for part-time labor were twice those for full-time labor. Payments for part-time and seasonal labor dropped $10 per acre, or 24 percent, between 1990 and 1991 for farmers with NIL contracts, while full-time labor costs fell $5 per acre, or 12 percent. This suggests that the Bank had a larger effect on part-time or seasonal labor than on full-time labor.

As shown in the bottom half of Table 2.8, changes in the inputs used per acre for farmers with GWEL contracts were small.

## *Impact of Total Bank Purchases on Operating Costs*

The impacts on operating costs that we observe in our sample of 95 farmers allow us to predict the impact for all farmers participating in the Bank. To do this, we multiply the change in operating cost per acre-foot estimated above by the total amount of water sold to the Bank on a crop-by-crop basis. We then compare the change in operating costs to what they would have been in 1991 had there been

no Bank. The methodology is detailed in Appendix A. We estimate the impact of NIL contracts separately from GWEL contracts.

To project the impacts of the entire Bank, we must allocate the 100,000 acre-feet bought through multiple-response contracts to NIL and GWEL contracts. Based on the farmer survey and interviews with water agency staff, we estimate that 33,000 acre-feet came as surface-water reductions for farmers with no groundwater pumps. We combine this with the 420,000 acre-feet from no-irrigation contracts, and, consequently, extrapolate our findings for the NIL contracts to 453,000 acre-feet. We estimate that 67,000 acre-feet of the multiple-response water came from farmers with groundwater pumps and likewise combine it with the 140,000 acre-feet from groundwater-exchange contracts.

We estimate that the 453,000 acre-feet purchased through NIL contracts caused operating costs to be $17.1 million lower in 1991 than they would have been had there been no Bank (see Table 2.9). The 90-percent confidence interval for this estimate runs from –$25.7 to –$8.5 million. This represents an 18-percent drop in the operating costs with a 90-percent confidence interval of 9 to 27 percent. Consistent with our earlier results, we estimate a small, statistically insignificant drop in operating costs for farmers with GWEL contracts.

## *Impact of the Bank on Farm Investment and Total Input Purchases*

We asked farmers how their investments in the farm changed between 1990 and 1991. These investments included purchase and repair of farm equipment, groundwater well installation and overhaul, building maintenance, irrigation and drainage improvements, and laser leveling. We then used the same methodology as above to isolate the impact of the Bank from other factors. The statistical analysis is described in Appendix A.

**Table 2.9**

**Impact of Total Bank Purchases on Operating Costs by Contract Type**

| | NIL | GWEL |
|---|---|---|
| AF sold to Bank (1000s) | 453 | 207 |
| Change in operating costs | | |
| Estimate ($millions) | –17.1 | –0.6 |
| 90-percent confidence interval ($millions) | [–25.7, –8.5] | [–2.5, 1.2] |
| Percentage change | –18 | –1 |
| 90-percent confidence interval | [–27, –9] | [–3, 2] |

We estimate that farmers with NIL contracts invested $2.5 million more in their farms in 1991 than they would had there been no Bank. The uncertainty in this estimate is large enough, however, that we cannot statistically reject the hypothesis that it is zero. As reported in Table 2.10, the estimated increase in farm investment caused overall purchases of farm inputs by these farmers to drop $14.6 million. Thus, farm investment offsets about 15 percent of the drop in operating costs.

As discussed above, it likely that some farm investments are included in the operating cost numbers. This would cause our estimate of farm investment to be too low, but it would not affect our estimate of the change in overall input purchases.

It also appears that the Bank caused farmers with GWEL contracts to increase farm investments, but, again, the uncertainty is large relative to the point estimate. We estimate that farmers with these contracts increased farm investment $3.2 million over what it would have been in 1991. This causes overall input purchases to actually rise somewhat, but the rise is not statistically different from zero.

While it appears that increases in farm investment partially offset the fall in operating costs, the increased spending did not necessarily benefit the same people hurt by the fall in operating costs. Table 2.11 describes the changes in farm investment as reported by the farmers surveyed.[16] For farmers with NIL

**Table 2.10**

**Impact of Total Bank Purchases on Operating Costs, Farm Investment, and Total Input Purchases by Contract Type ($million)**

| | NIL | GWEL |
|---|---|---|
| Operating costs | –17.1 | –0.6 |
| 90-percent confidence interval | [–25.7 –8.5] | [–2.5, 1.2] |
| Farm investment | 2.5 | 3.2 |
| 90-percent confidence interval | [–2.3, 7.3] | [–2.8, 9.2] |
| Total input purchases | –14.6 | 2.6 |
| 90-percent confidence interval | [–25.4, –3.8] | [–4.1, 9.3] |

[16]As with the changes in the components of operating costs, these are not changes due to the Bank, but the changes reported in the survey. They suggest how the increase in farm investment due to the Bank was distributed.

**Table 2.11**

**Composition of Farm Investment by Contract Type (percent)**

| Activity | NIL | GWEL |
|---|---|---|
| Farm equipment purchase and repair | 54 | 26 |
| Groundwater well installation and overhaul | 0 | 67 |
| Building maintenance | 25 | 3 |
| Irrigation and drainage improvements | 15 | 4 |
| Laser leveling | 6 | 0 |
| **Total** | 100 | 100 |

contracts, the majority of additional investment went to farm equipment purchases and repair. For farmers with GWEL contracts, the bulk of additional investment went for groundwater well installation and overhaul.[17]

## Impact of the Water Bank on Crop Sales

We now turn to the impact of the Bank on crop sales by farmers and investigate the same issues we did for operating costs. Lower crop sales (holding crop price constant) for any particular crop means less business for the processors and handlers of that crop. However, the size of the impact of the Bank on crop sales for an individual crop does not necessarily correspond to the size of the impact on firms that handle or process farm products. For example, an acre-foot of water sold by putting alfalfa in the Bank may have a greater impact on crop sales than wheat, since the value of alfalfa per acre is higher, but it may generate less downstream processing and handling if it is primarily used for animal fodder. Without further analysis we are therefore unable to determine which crops have a bigger impact on processors and handlers of farm products. The overall decline in crop sales caused by the Bank for all crops, however, may be a rough indicator of the overall decline in the businesses of crop processors and handlers. Below, we will first investigate how the impact of the Bank on crop sales varies by type of contract and crop and then the impact of the Bank on overall crop sales.

### *Changes in Farm Crop Sales*

Average crop sales per acre in the entire farm operation dropped by $174 or 33 percent for the farmers surveyed with NIL contracts (see Table 2.12). As a

[17]Many farmers reported that they used some of their Bank revenues to pay down their debt. This may not have had any impact on third parties in the short run, but it may have helped keep the farmers in business, which may be a longer-term benefit to third parties.

**Table 2.12**

**Change in Crop Sales per Acre in Farm Operation by Contract Type (not necessarily attributable to the Bank)**

| | NIL | GWEL |
|---|---|---|
| Observations | 73 | 10 |
| Average crop sales | | |
| 1990 ($/acre) | 534 | 1,041 |
| 1991 ($/acre) | 360 | 965 |
| Change ($/acre) | –174 | –76 |
| Percent change | –33 | –7 |

reminder, farmers with NIL contracts are those with no-irrigation contracts and three with no groundwater pumps in agencies with multiple-response contracts. Not all farmers surveyed were willing or able to provide crop income information, so the sample size is smaller than it is for changes in input purchases. Ten farmers with GWEL contracts reported that crop sales fell 7 percent between 1990 and 1991. Farmers with GWEL contracts are those with groundwater-exchange contracts or those with groundwater pumps in agencies with multiple-response contracts. Because we have not yet controlled for other factors, these changes are not attributable to the Water Bank.

## *Changes in Crop Sales Due to the Water Bank*

For farmers with NIL contracts, the impact of the Bank on crop sales varied by the crop (see Table 2.13). Crop sales dropped $287 per acre-foot sold for sugar

**Table 2.13**

**Change in Crop Sales per Acre-Foot Sold to Water Bank Attributable to Water Bank by Contract Type**

| Type of Contract | Change per AF Sold ($/AF)[a] | 90-Percent Confidence Interval |
|---|---|---|
| NIL contracts | | |
| Sugar beets | –287[b] | [–350, –223] |
| Alfalfa | –156[b] | [–205, –106] |
| Other | –143[b] | [–221, –65] |
| Corn | –138[b] | [–215, –60] |
| Rice | –117 | [–263, 28] |
| Wheat | –108[b] | [–193, –22] |
| Pasture | –38 | [–89, 14] |
| GWEL contracts | | |
| Groundwater available | –92[c] | [–166, 18.6] |

[a]The units are ($/acre)/(AF/acre) or $/AF.

[b]Significantly different from zero at 95-percent confidence.

[c]Significantly different from zero at 90-percent confidence.

beets and between $108 and $156 for wheat, rice, corn, alfalfa, and crops in the "Other" category. The impact of pasture was the smallest and not statistically different from zero.

Although Table 2.13 suggests a negative relationship between crop sales and water sold to the Bank for farmers with GWEL contracts, the effect is uncertain because there are so few observations. It does suggest, however, that while operating costs for farmers who pumped groundwater did not change much, there may have been a drop in crop yields and crop sales. Farmers with GWEL contracts grew rice almost exclusively. Figure 2.2 plots the change in rice yields between 1990 and 1991 for 12 of the 13 farmers with GWEL contracts who could provide the data. The figure suggests that yields were lower for farmers who sold more water to the Bank.

One possible explanation for the lower yields is that groundwater was of lower quality than the surface water it replaced. This might be because it was higher in total dissolved salts or temperature (both of which can reduce crop yield). Due to limited pumping capacity, farmers may also not have been able to apply the groundwater when they wanted to. Another possible explanation is that farmers in districts with groundwater-exchange contracts would have normally used their groundwater wells and thus reduced their combined use of surface water and groundwater when their districts sold water to the Bank.[18,19]

### *Factors Behind the Variation in Impacts on Crop Sales*

Table 2.14 compares the estimated Bank effect on crop sales for NIL contracts per acre put in the Bank with the normal crop income as calculated from the product of average yield and 1991 price received at the farm.[20] As expected, the ordering of crops by Bank impact per acre generally corresponds to the normal income.

As with operating costs, we investigate the relation between crop sales impact and type of contract. Analogous to the results for operating costs, the type of contract by itself is not a very good predictor of the ratio of impact per acre and

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[18]As an illustration, consider a farmer who normally used 80 acre-feet of surface water and 20 acre-feet of groundwater (100 acre-feet total). Say that the farmer pumped 40 acre-feet under a groundwater-exchange contract and sold 40 acre-feet of surface water to the Bank. The farmer would then have 40 acre-feet of groundwater but would only have 40 acre-feet of surface water remaining, for a total of 80 acre-feet.

[19]For multiple-response contracts where groundwater was available, farmers may not have fully offset surface water sales with groundwater pumping if there was limited pump capacity or the cost of pumping was higher than the cost of surface water.

[20]Prices received by farmers provided by California Agricultural Statistics Service, U.S. Department of Food and Agriculture, Sacramento, CA. Yields based on average yields (in 1990) of farmers surveyed.

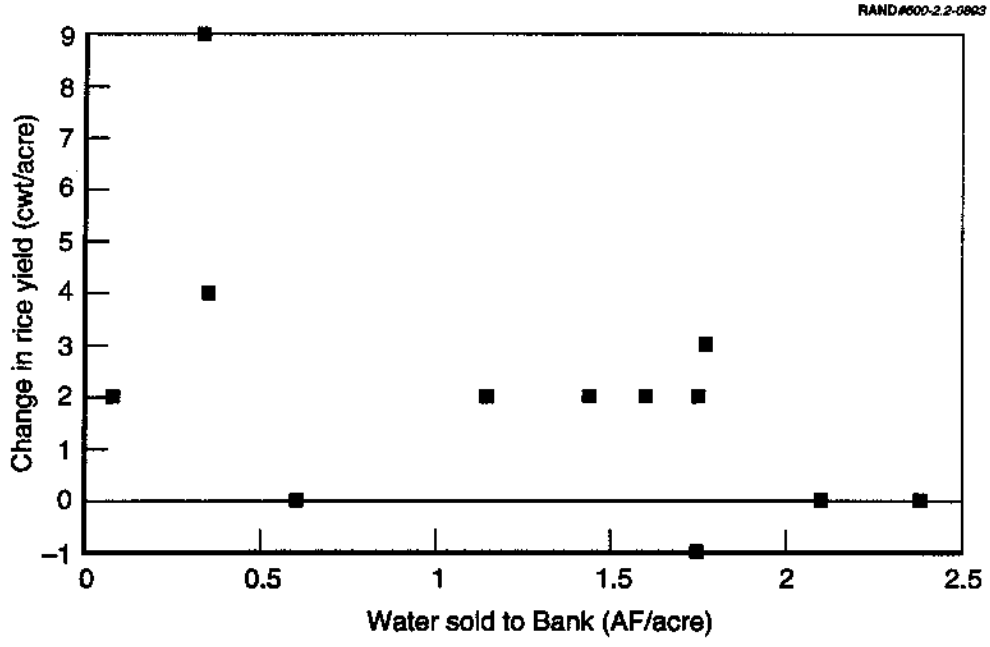


**Figure 2.2—Change in Rice Yield Versus AF/Acre Sold to Bank for GWEL Contracts**

**Table 2.14**

**Comparison of Statistical Estimate of Change in Crop Sales with Normal Crop Income for NIL Contracts**

| | Change per AF sold (1) | AF Purchased per Acre in Bank (2) | Impact per Acre in Bank (3)=(1) × (2) | Normal Crop Income (4) |
|---|---|---|---|---|
| Sugar beets | −287 | 2.8 | −804 | 770 |
| Alfalfa | −156 | 3.3 | −515 | 595 |
| Rice | −117 | 3.4 | −398 | 600 |
| Other | −143 | 2.5 | −358 | — |
| Corn | −138 | 2.2 | −304 | 355 |
| Wheat | −108 | 1.8 | −194 | 308 |
| Pasture | −38 | 3.1 | −118 | NA |

normal crop income. For example, as the last column of Table 2.15 shows, alfalfa is planted but not irrigated, but its impact relative to its normal income is quite high, in fact, higher than those for either rice or corn, which are not planted. Ceasing to irrigate alfalfa thus appears to severely curtail yield. This again suggests that both the particular characteristics of the crop and the type of contract are important in determining the impact on crop sales.

One might expect the ratio of Bank impact to normal crop income to be near unity for crops that are not planted. The ratio for sugar beets is indeed close to

**Table 2.15**

**Relation of Impact of Bank on Crop Sales to Normal Crop Income by Type of NIL Contract**

| Crop | Impact per Acre Not Irrigated (1) | Normal Crop Income (2) | Ratio (1)/(2) |
|---|---|---|---|
| Planted, not irrigated | | | |
| Alfalfa | –515 | 595 | –0.87 |
| Wheat | –194 | 308 | –0.63 |
| Pasture | –118 | NA | NA |
| Not planted | | | |
| Rice | –398 | 600 | –0.66 |
| Sugar Beets | –804 | 770 | –1.04 |
| Corn | –304 | 355 | –0.86 |

one, but it appears to be lower than one for corn and rice. Ratios below one are possible. Here, we are looking at crop income per acre in the entire farming operation, and a farmer may increase the inputs applied to acres that are not in the Bank, causing yields to rise on that land and average crop revenues across the whole farm to decrease less than otherwise. Our results suggest that this may be the case for corn and rice, although the uncertainty in our estimate of the effect on sales of these crops does not allow us to statistically reject the hypothesis that the ratio is one.[21]

## *Impact of the Total Bank Purchase on Crop Sales*

We estimate that total Bank purchases through NIL contracts caused crop sales to be $58.0 million, or 29 percent, lower in 1991 than they would have been had there been no Bank (see Table 2.16). The 90-percent confidence intervals around these estimates are fairly large, ranging from –$81.4 to –$34.6 million and –40 to –17 percent, respectively.

Crop revenues dropped an estimated $19.1 million, or 10 percent, for farmers with GWEL contracts. While this again suggests that crop sales fell for GWEL contracts, the confidence intervals are large and the decline is not statistically different from zero.

[21]Using the lower bounds from the 90-confidence intervals for the impact of rice and corn on crop sales produces ratios of 1.49 and 1.33, respectively.

**Table 2.16**

**Impact of Total Bank Purchases on Crop Sales by Water Source**

| | NIL | GWEL |
|---|---|---|
| AF sold to Bank (1,000) | 453 | 207 |
| Change in crop sales | | |
| Estimate ($millions) | –58.0 | –19.1 |
| 90-percent confidence interval ($millions) | [–81.4, –34.6] | [–34.3, 3.9] |
| Percent change | –29 | –10 |
| 90-percent confidence interval (percent) | [–40, –17] | [–18,–2] |

## Impacts of the Bank by County

In this subsection, we break down the reduction in operating costs and crop sales by county. We compare these declines to what operating costs and crop sales would have been in 1991 had there been no Bank.

To calculate Bank impacts by county, we break down water sales by county by crop and contract type and multiply the amount sold by the impacts per acre-foot on operating costs and crop sales estimated above. We use the previous methodology to estimate what farm operating costs and crop sales would have been in 1991 by county had there been no Bank. Both sets of calculations are described in Appendix A.

Table 2.17 reports the water sold by contract type in each county. (Sales by crop for no-irrigation and groundwater contracts are reported in Appendix A.) Table 2.18 reports the estimated impact of the Bank by county, our estimate of what

**Table 2.17**

**Acre-Feet Sold to Bank by County and Contract Type (000s acre-feet)**

| County | NIL | GWEL | Total |
|---|---|---|---|
| Butte | 40 | 62 | 102 |
| Colusa | 8 | 26 | 34 |
| Contra Costa | 27 | 0 | 27 |
| Glenn | 1 | 2 | 3 |
| Sacramento | 67 | 0 | 67 |
| San Joaquin | 123 | 0 | 123 |
| Shasta | 16 | 0 | 16 |
| Solano | 47 | 0 | 47 |
| Sutter | 18 | 10 | 28 |
| Yolo | 106 | 27 | 133 |
| Yuba | 0 | 79 | 79 |
| **Total** | 453 | 207 | 660 |

**Table 2.18**

**Change in Countywide Farm Operating Costs Due to the Water Bank**

| | $million | | | | |
|---|---|---|---|---|---|
| County | NIL | GWEL | Total | Estimated 1991 Operating Costs Without Bank | Percent Change |
| Butte | –3.0 | –0.2 | –3.2 | 56.3 | –6 |
| Colusa | –0.7 | –0.1 | –0.8 | 57.7 | –1 |
| Contra Costa | –0.7 | 0 | –0.7 | 12.2 | –6 |
| Glenn | 0.1 | 0 | 0.1 | 48.8 | –0.2 |
| Sacramento | –2.3 | 0 | –2.3 | 71.0 | –3 |
| San Joaquin | –4.4 | 0 | –4.4 | 127.5 | –3 |
| Shasta | –0.3 | 0 | –0.3 | 14.9 | –2 |
| Solano | –1.3 | 0 | –1.3 | 100.9 | –1 |
| Sutter | –1.1 | 0 | –1.1 | 84.1 | –1 |
| Yolo | –3.3 | –0.1 | –3.4 | 132.8 | –3 |
| Yuba | 0 | –0.2 | –0.2 | 20.0 | –1 |
| **Total** | –17.1 | –0.6 | –17.7 | 726.2 | –2 |

farm operating costs would have been in 1991 had there been no Bank, and the estimated percentage change in operating costs caused by the Bank.[22]

Impacts in individual counties range from nearly zero in Glenn County, where little water was purchased, to –6 percent in Butte and Contra Costa. The absolute impact of the Bank in Contra Costa was not large, but the small size of the farming sector in Contra Costa causes the percentage change to be the largest. The largest absolute impacts were in San Joaquin and Yolo counties, where county farm operating costs fell 3 percent. The last row in Table 2.18 shows that operating costs fell 2 percent overall in these eleven counties.

Because impacts vary by type of crop, the counties that sold more water to the Bank do not always show larger impacts for NIL contracts. For example, Contra Costa County sold more water to the Bank through NIL contracts than Sutter County, but a large portion of Contra Costa's water came from pasture and corn, which have relatively low unit impacts. Much of the water from Sutter came through NIL contracts for rice, which have higher unit impacts.

Table 2.19 reports the same statistics for crop sales. As before, the smallest percentage decline was in Glenn County, and the largest dollar losses were in San Joaquin County and Yolo County. This time, the largest percentage declines were in Yolo and Yuba counties, but the percentage decline in Contra Costa was

[22]While water was bought in Stanislaus and Tehama counties, the amounts were negligible. We assume that the impacts of the Bank on operating costs in these counties are negligible and exclude them from these calculations.

**Table 2.19**

**Change in Countywide Crop Sales Due to the Water Bank**

| | $million | | | | |
|---|---|---|---|---|---|
| County | NIL | GWEL | Total | Estimated 1991 Crop Sales Without Bank | Percent Change |
| Butte | -4.3 | -5.8 | -10.1 | 249 | -4 |
| Colusa | -0.9 | -2.5 | -3.4 | 221 | -2 |
| Contra Costa | -3.1 | 0.0 | -3.1 | 73 | -4 |
| Glenn | -0.1 | -0.2 | -0.3 | 184 | -0.2 |
| Sacramento | -8.6 | 0.0 | -8.6 | 234 | -4 |
| San Joaquin | -18.1 | 0.0 | -18.1 | 863 | -2 |
| Shasta | -1.0 | 0.0 | -1.0 | 60 | -2 |
| Solano | -5.7 | 0.0 | -5.7 | 187 | -3 |
| Sutter | -2.6 | -0.9 | -3.5 | 273 | -1 |
| Yolo | -13.6 | -2.3 | -15.9 | 246 | -6 |
| Yuba | 0 | -7.3 | -7.3 | 118 | -6 |
| **Total** | -58.0 | -19.1 | -77.1 | 2,708 | -3 |

still among the largest. Overall, we estimate that crop sales fell 3 percent in the 11 counties directly affected by the Bank.

These results show that the impact of the Bank varied by county. Some counties were not affected at all, while others saw operating costs or crop sales fall up to 6 percent. There is also some anecdotal evidence that the impacts were concentrated in regions within these counties. For example, investigations by DWR staff raised concerns that the farming community of Clarksburg in Yolo County was particularly hard hit by the Bank.[23]

The Bank caused substantial drops in operating costs and crop sales for the farmers who participated in the Bank. However, at 2 percent for operating costs and 3 percent for crop sales, these overall declines are not large compared with total farm operating costs in the 11 counties selling water to the Bank. In Section 3, we investigate how these changes compare to historic variations in the farm economy.

## Farmer and Landlord Net Income from the Bank

We conclude this section by examining net revenue generated by the Bank sales for the farmers, landlords, and water agencies who sold water to the Bank. Here,

[23]DWR (1993), p. 18.

the focus is not on the suppliers of farm inputs or the handlers and processors of farm outputs, but on the parties directly involved in the transfers.

As shown in Table 2.20, DWR paid $56.6 million to holders of NIL contracts. The farmers who either entered into these contracts or farmed the land owned by landowners who entered into these contracts saved $17.1 million in operating costs but forwent $58.0 million in crop sales. Therefore, NIL contracts generated $15.7 million, or $35 per acre-foot, more net revenue than would have been generated had the land not been put in the Bank. This finding implies that DWR would have found many willing sellers at less than $125 an acre-foot. However, how many sellers with NIL contracts would have dropped out at lower prices is unknown. It would depend on the distribution of profits across the contracts, and how the farmers treat risk. The 1992 Bank demonstrated that DWR could buy 193,000 acre-feet primarily through groundwater exchange at $50 per acre-foot; however, determining how much water DWR could buy over a range of prices is beyond the scope of this study.[24]

How was the increase in net revenue generated by NIL contracts divided? Table 2.21 reports that, for NIL contracts, landlords received 6 percent of the Bank payments for the contracts in our sample, while the water agency or county received 1 percent. Landlords received a small share of Bank proceeds, but we do not know how this compares with the portion of land put in the Bank that

**Table 2.20**

**Net Benefits of the Bank to Farmers, Landlords, and Water Agencies**

| | NIL | | GWEL | |
|---|---|---|---|---|
| | Total ($million) | Per AF Sold ($/AF) | Total ($million) | Per AF Sold ($/AF) |
| Water Bank payments | 56.6 | 125 | 25.9 | 125 |
| Saving on inputs | 17.1 | 38 | 0.6 | 3 |
| Increased pumping cost | 0 | 0 | –3.9 | –19 |
| Change in crop revenues | –58.0 | –28 | –19.1 | –92 |
| Net contract revenue | 15.7 | 35 | 3.5 | 17 |
| Payment to landlord | 3.4 | 8 | 8.8 | 42 |
| Payment to water agency | 0.6 | 1 | 4.4 | 21 |
| Net benefit to farmer | 11.7 | 26 | –9.7 | –46 |

[24]The distribution of the profits across contracts could be determined by propagating the error distribution in the models for operating costs and crop sales to net contract revenue.

**Table 2.21**

**Recipients of Water Bank Payments for Farms Surveyed (percent)**

| | NIL (N=82) | GWEL (N=13) |
|---|---|---|
| Landlord | 6 | 34 |
| Water agency or county | 1 | 17 |
| Farmer | 93 | 49 |
| **Total** | 100 | 100 |

was rented. Farmers with NIL contracts leased 37 percent of the land in these operations, but the percentage could be lower for land in the Bank.

The numbers for the GWEL contracts tell a different story, although given the small sample size, they must be interpreted with much more caution. Overall, GWEL contracts generated $3.5 million, or $17 per acre-foot, in surplus. These farmers reduced operating costs $0.6 million but paid $3.9 million more in pumping costs[25] and forewent $19.1 million in crop revenues. This again suggests that DWR would have found willing sellers at less than $125 an acre-foot.

Landlords received approximately one-third of the Water Bank payments, according to the 13 farmers in our sample. While much higher than the share for NIL contracts, it is not large given that the farmers in our sample leased 78 percent of the land in their operations. Water agencies also received a sizable share (17 percent) of the payments by the Bank. This reflects their central role in negotiating and administering the GWEL contracts. Overall, it appears that the farmers in districts with GWEL contracts did not benefit from the Bank.[26] Farmers may ultimately benefit from the earnings retained by the water agencies, but this would at best offset only part of their losses.

The overall negative benefit does not mean that no farmers with GWEL contracts benefited from the Bank. It does imply that some did much worse than they would have if there had been no Bank. One such case is a farmer we surveyed who had his surface water allocation reduced but did not even know his water district had sold water to the Bank. Needless to say, this farmer received no revenues from the Bank.[27]

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[25]The increase in groundwater pumping costs averaged $19 per acre-foot sold to the Bank for the farmers with GWEL contracts.

[26]One would expect owner-operators to fair better than tenants, who may have to share Bank revenues with landlords.

[27]Presumably his landlord received the payments.

## Summary

In this section, we have investigated the impact of the Bank on the suppliers of farm inputs and processors and handlers of farm outputs by examining changes in farm input purchases (excluding water costs) and crop sales caused by the Bank.

We found that the Bank had a sizable impact on the purchases of farm inputs by farmers participating in the Bank. We estimate that farmers participating in the Bank reduced operating costs by $17.7 million, or 11 percent, because of the Bank. All components of operating costs declined for NIL contracts, but the decline for part-time labor was twice that for full-time labor.

We found that the impacts on operating costs varied importantly by type of contract and crop. Water sales by farmers with NIL contracts (those with no-irrigation contracts and those in districts with multiple-response contracts without groundwater pumps) caused operating costs to fall 18 percent. In contrast, we found no statistically significant change in the operating costs for farmers with GWEL contracts. Per acre-foot sold, water generated by not irrigating rice, sugar beets, and alfalfa had the largest impacts of the crops for which we were able to identify individual effects. Wheat and corn had intermediate impacts on operating costs, and pasture had no detectable impact.

We estimate that farmers with NIL or GWEL contracts invested $5.7 million more in their farms than they would have had there been no Bank. We also estimate that increased farm investment offset approximately 32 percent of the decline in farm operating costs. While farm investment caused the decline in purchases of overall farm inputs caused by the Bank to be lower than they would have been otherwise, the people and businesses that benefited from the increased farm investment are not necessarily the same ones hurt by the decrease in operating costs.

We also found that the Bank had a sizable impact on the crop sales of farmers participating in the Bank. We estimate that crop sales were $77.1 million, or 20 percent, lower in 1991 for farmers in the Bank than they would have been had there been no Bank. While the impact varied by crop and contract type, we cannot link the size of these impacts to the impact on output processors and handlers. To do this, further research is required to quantify the downstream processing requirements of individual crops. In contrast to their impact on operating costs, the GWEL contracts appear to have a sizable impact on crop sales. This appears to result at least in part from lower crop yields. Possible explanations are that groundwater had lower quality or could be applied with

less flexibility. Our findings suggest that it cannot be assumed that GWEL contracts have no impacts on third parties.

While the declines in operating costs and crop revenues were sizable for the farmers in the Bank, they are not large compared with the total operating costs or crop sales in the 11 counties that sold water to the Bank. We estimate that operating costs were 2 percent lower and crop sales were 3 percent lower in the 11 counties than they would have been had there been no Bank. The impact varied across individual counties, depending on the amount of water sold, the type of contract, and the type of crop.

In the last part of this section, we turned our attention from the impact of farmer decisions on third parties to the net revenue generated by the Bank for farmers, landlords, and water agencies. We found that NIL contracts increased net revenues $35 per acre-foot sold over what they would have been had there been no Bank. This suggests that DWR would have found many willing sellers if the purchase price had been less than $125 per acre-foot, but determining how many sellers would have dropped out at lower prices requires further analysis. Landlords and water agencies do not appear to have captured a large share of the Bank payments for NIL contracts.

GWEL contracts also generated an overall surplus, but at $17 per acre-foot, it is much less than the $35 per acre-foot for the NIL contracts. There is considerable uncertainty in the estimates for GWEL contracts, however, since they are based on a small number of observations. Landlords and water agencies together received over 50 percent of payments through GWEL contracts. The net result was that, on average, the farmers themselves did not benefit from participating in the Bank. This apparently results from some cases where farmers had their surface water allocations reduced but received no compensation.